1. Describe the practice proposed for recognition, and list its objectives. Detail how the practice is innovative and how it promotes high student achievement.

This practice, Astronomy Day and Night, done with third and fourth graders throughout the school year, teaches children astronomy through a series of scaffolded, inquiry-based activities. The activities include: Sundials; Sun Domes; Moon Journals; Modeling the Sun-Moon-Earth System and Other Problems; Impact Craters; NASA's Lunar Rocks and Meteorite Samples; Scale Model of Earth-Moon Volumes; Solar System Walk; Make-a-Comet; Starfinders and Constellations; Star Lab Planetarium; Constructing Telescopes; Using Binoculars and Telescopes; Acting to Model a Celestial Motion; and Holding an Evening Star Party.

Following is a brief summary of each activity. Sundials: Students record the apparent motion of the sun across the sky by tracing the shadow that the sun casts of a short, upright stick (a gnomon) at regular intervals. Sun Domes: Students plot the apparent path of the sun across the sky during the day for each season of the year. Moon Journals: Students observe and keep a record of the moon, looking for patterns in it shape and its apparent motion in the sky. Modeling the Sun-Moon-Earth System and Other Problems: Students model phenomena that they've observed, such as day and night, seasons, and phases of the moon, to better understand how the positions and motions of the sun, moon, and earth effect these events. Impact Craters: Students investigate impact craters on the moon by experimenting with colliding objects in a bin of flour. NASA's Lunar Rocks and Meteorite Samples: Students observe lunar rock and meteorite samples under a microscope. Scale Model of Earth/Moon Volumes: Students create a model demonstrating the relationship between the volume of the Earth and the volume of the Moon. Solar System Walk: This scale model of the diameters of the sun and planets in our solar system as well as the distances between the planets gives students an impression of the vast sizes and distances in our solar system. Make-a-Comet: After making a "comet" using the same ingredients of which comets are made, students attempt to recreate conditions (sun and wind) that affect comets as they revolve around the sun. Star Finders and Constellations: Students construct and use star finders as maps of the night sky. Star Lab Planetarium: In this 12' planetarium, students learn to identify major stars and constellations in the night sky and hear their accompanying stories. Constructing Telescopes: Students construct telescopes using tubes and lenses. Using Binoculars and Telescopes: Students use binoculars and telescopes during the day to view the moon and at night to view other celestial objects. Acting to Model a Celestial Motion: Students choose a celestial phenomenon to act out. (1) Students demonstrate how the zodiac constellations act as a "heavenly" backdrop for closer objects in the sky. (2) Students demonstrate the motions of the solar system in the gymnasium. Evening Star Party: Students and families participate in an evening star party using binoculars and telescopes.

The objectives in this program are: (1) to make the study of astronomy possible during the daytime in school (since so much astronomy is done at night) (2) to give opportunities to children to observe naturally occurring events and objects in the sky, notice changes in the sky, discover patterns, develop their own questions and hypotheses, and find answers (3) to help children learn from models (4) to foster in children excitement for learning, science, and astronomy.

This program is innovative because it takes a subject that is difficult to teach in the classroom and develops it using inquiry-centered, hands-on classroom activities in conjunction with homebased, evening activities. One difficulty in learning astronomy is that students cannot manipulate (and experiment with) what they are studying because the objects are too big and too far away! A difficulty for learning astronomy in school is that much astronomical activity takes place at night. However, this program combines homework assignments (look for the moon and draw what you see) with classwork (talk about what you noticed and what you drew). It uses objects that can be seen during the day (the sun and sometimes the moon). Another difficulty in

teaching astronomy is that students come into school with misconceptions based on their own casual observations (eg. the sun revolves around the Earth; the different seasons on Earth are caused by the differences in distances between the Earth and the Sun at varying times). Our program focuses on good observing techniques followed by model-making as a method of replicating real life (to the best of our ability), conducting experiments using the models, and finding answers that can be related to the real world. Students demonstrate and communicate their findings to others, also as scientists do in the scientific world.

What can be more engaging to children than to be awakened in the middle of the night by their parents to see the Leonid meteor showers and come into school the next day (tired, but happy) to tell their story and draw pictures of what they had seen! A memorable experience like that is bound to inspire and engage children (and their parents) in finding out more about the night sky. To learn that the meteor shower was caused by the earth passing through comet debris and then to make a comet in school is heavenly! Children's thirst for knowledge is nourished by offering opportunities that will engage them physically (by doing), intellectually (by thinking), and emotionally (by feeling motivated by and attached to the subject).

Astronomy Day and Night promotes high student achievement because the students have done the work themselves! They have observed the moon and drawn pictures of it for a month, found patterns and then have observed the moon for a second month to verify their hypotheses. They don't have to memorize the names of the phases of the moon - they know them because they have used them so frequently. They have observed the apparent path of the sun on their sun domes during the day for each season, resulting in insight into the causes of the seasons. They have outlined shadows of gnomons and themselves during the day. They have asked questions and found answers by observing, modeling, and reading. This level of interaction with materials and each other through discussions and even with objects they can't touch but can observe brings true learning to students.

2. List the specific *Core Curriculum Content Standards, including the Cross-Content Workplace Readiness Standards,* addressed by the practice and describe how the practice addresses those standards. Provide an example to substantiate your response.

Science Standard 5.11: All students will gain an understanding of the origin, evolution, and structure of the universe.

In order to begin to reach this standard, children in grades 3 and 4 should be observing and identifying objects and their apparent motion in the day and night sky. (5.11.1) Sundials, Sun Domes, Moon Journals, Star Finders, and Star Lab Planetarium are activities that help children observe and identify objects in the sky and patterns in the motions of those objects. Then children connect those apparent motions with units of time (day-night, month, seasons). The next step in understanding is to learn more about the real motions of celestial bodies and their relationship to units of time (days, months, season, and years). (5.11.2) The activity Modeling the Sun-Moon-Earth System and Other Problems combines with the abovementioned ones to discover and demonstrate the why's of their observations. As the children gain more experience, they step further out into the solar system by learning more about the properties and motions of the planets of our solar system. (5.11.3, 5.11.4) (Scale Model of Earth/Moon Volumes, Solar System Walk, Solar System Motion Model, Make-a-Comet).

Science Content Standards 5.1 - 5.5, describing science process standards, are addressed in this practice. 5.1 describes an understanding of systems. In our program, students look at the Sun-Moon-Earth system and the Solar System and how the parts fit into the whole. Standard 5.2 describes problem-solving. There are many problems that students solve in our program. By creating and conducting cratering experiments (Impact Craters), they learn the skill of experimental design. By using styrofoam balls on skewer sticks to represent celestial bodies and lamps to represent the sun, students learn to solve questions that they have asked about

naturally occurring events, such as day and night, the phases of the moon, and eclipses. (Modeling the Sun-Moon-Earth System and Other Problems) Standard 5.3 describes students' awareness of science and technology in an historical perspective. Building telescopes in our program allows students to experience the telescope that Galileo used when he looked at the moon and also when he discovered the moons of Jupiter. Standard 5.4 describes students developing an understanding of technology as an application of scientific principles. In our program, children investigate mirrors and their properties before placing them in the telescopes. This helps them understand how a telescope works. (Building Telescopes) Standard 5.5 is the mathematics standard. Our program uses mathematics in relation to scale modeling and in trying to understand the huge numbers involved in astronomy (Scale Model of Earth/Moon Volumes, Solar System Walk, Solar System Model).

Cross-Content Workplace Readiness Standards 1-5 are addressed in this practice. Standard 1 describes work habits that should be practiced, such as work ethic, dependability, and getting along with others. Our program relies on the students' responsibility towards each other (looking for the moon each night in order to make a class moon calendar) and getting along with others while working in small group activities. Standard 2 describes the use of information, technology, and tools. In our program, students get information and news from newspapers, tv, and the internet about current astronomical events. They learn to use and respect adult equipment, such as binoculars and telescopes. Standard 3 describes critical thinking, decision-making and problem-solving skills. In our program, students think critically when they interpolate missing data on the moon calendar, predict the next night's moon shape, hypothesize answers for their questions or reasons for the seasons, and design an experiment that would test how the mass of an impacting object would affect the depth of the crater that it creates. Standard 4 describes how students should practice self-management skills, such as time-management and co-operative work skills. The activities in our program require students to work responsibly towards the group and themselves. Standard 5 describes application of safety principles. Students in the program learn to use goggles when using chemicals (Make-a-Comet) and to safely use telescopes and binoculars.

3. Describe the educational needs of students that the practice addresses. Document the assessment measures used to determine the extent to which the objectives of the practice have been met. Provide assessments and data to show how the practice met these needs.

An important educational need of the students is to learn at their own level of understanding and experience. In our class, there is a large range of academic skill and home support. Astronomy Day and Night activities are open-ended enough to reach all children on their own level. One child may draw a picture of just the shape of the moon each night, while another child may draw the entire scene by the moon, including a tree, telephone wires, a roof top or horizon. Another child may set an observational experiment for him or herself and observe the apparent path of the moon in one night or the position of the moon in the sky at the same time each night for five nights in a row. The level of performance depends on each child's unique qualities brought to the activity. Every child is expected to work to the best of his or her ability. We have built-in support systems in class. For example, some children may have more support at home than others. For those who may have on occasion missed the moon at home, we construct a class moon calendar based on the data collected by the children. Then everyone may create a complete moon calendar, benefiting from the group's effort. In our program, children work by themselves, in pairs, and small groups. They help each other and work together. We also have large group discussions in which children learn from each other.

Another important educational need of the students is to be respected and listened to. By asking the students to observe, think, ask questions, hypothesize, and try to find answers, the teacher shows respect for the students' minds, and thus, supports their innate interest in

learning. Our program supports this inquiry-based method of learning. The teacher is sometimes giver of knowledge and often the facilitator who sets the stage and leads the students towards discovery.

We have several ways of assessing student learning. They include various methods of communication. (1) Students are periodically asked to write what they have learned in journal-style writing, once as a pre-assessment, several times during the course of the program, and once as a final assessment. The students are evaluated in terms of their individual growth and standard objectives. (2) Ongoing student work is evaluated. The students' participation in drawing moon journal pictures, creating experiments or models reveals much about their learning. (3) Paper-and-pencil tests, including essay and short-answer questions, are important evaluation tools when comparing performance to expected outcomes. (4) Participation in class discussions and even dialogues between teacher and student show what the student is thinking about. The teacher can learn a lot about a student's learning by looking at that student's questions, for a student must have a certain body of knowledge before being able to ask a question. (5) Teacher observation during class activities is ongoing and critical to the teacher in planning for the class and for the individual child.

One way of assessing the success of the program is to evaluate the level of participation both in school and out of school. Participation in homework and evening activities is very high in this pr4ogram (about 95 % of the children bring in their moon journal pictures each day; at least 85 % of children and their families come to star parties held in the evening; about 75% of the students saw the Leonid meteor showers in the middle of the night this past November 18th! Success is revealed when the students remember school at home and bring into school related information from home! Another way of assessing the success of the program is by evaluating student learning through the measures cited above. Teachers keep written documentation of these assessments, including anecdotal records, grades, and checklists. 100% of the children improve their knowledge from their pre-assessment and 100% of the children receive a "Satisfactory" or above on their tests. An additional effect of this program is the transference of skills learned and practiced in the program to other areas of study, including writing, reading, mathematics, and social studies, as well as to other science units.

4. Describe how you would replicate the practice in another school and/or district.

There are many ways of disseminating the ideas in this program and encouraging replication in the classroom. The key to replicating practices is professional development. Teachers are more likely to try something new in their classrooms if they have practiced it first themselves either with an instructor or colleague or after having read about it. They want to feel comfortable with the science content before introducing the unit to their students. The Best Practices booklet, the New Jersey Framework, professional journals, web site communications, handouts at workshops, share-a-thons, and showcases are ways to disseminate ideas through the written word. Other ways of sharing ideas are mentoring, conducting workshops, giving talks, providing videotaped lessons, and participating in study groups. I have conducted workshops for teachers and have written and disseminated curriculum materials for activities described in Astronomy Day and Night. I would be happy to conduct workshops and share my written materials with other teachers. In addition to the curriculum handouts, I have lists of resources, including related books, web sites, and field trips that will support the program.

Supplies for the activities in the program are readily available from school supply companies (colored paper, colored pencils, folders for Moon Journals; posterboard, skewer sticks, plasticene for Sundials); grocery stores (supplies for Impact Craters and Make-a-Comet); and Astronomy Educational Supply Companies (for Sun Domes, Telescope Kits).

Teachers choosing to replicate activities from Astronomy Day and Night will be able to find the support they need from organizations and people in the area, including this writer.